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A SURVEY OF THE AMBIENT AIR QUALITY IN THE PINCHER CREEK AREA

January 1 to March 24, 1981

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A SURVEY OF THE AMBIENT AIR QUALITY

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January 1 to March 24, 1981

prepared by

Air Quality Control Branch

Pollution Control Division

Alberta Environment

Edmonton, Alberta

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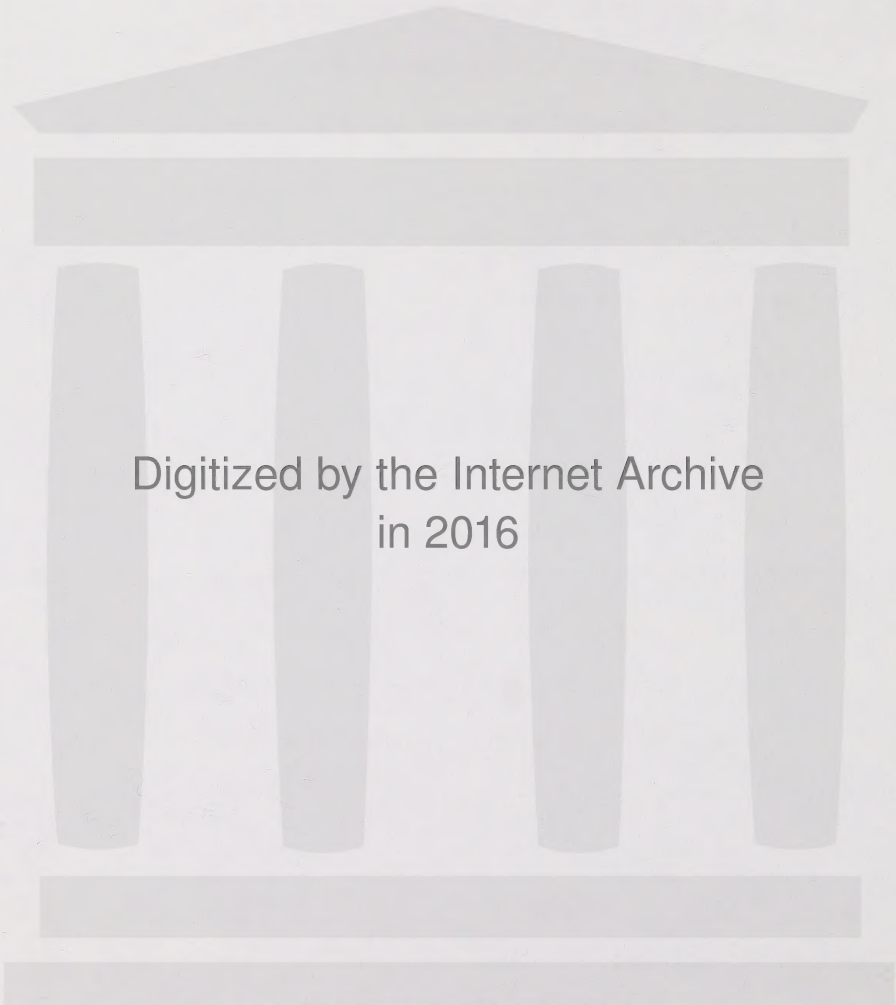
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SYNOPSIS

This report analyzes the results of the ambient air monitoring survey conducted in the Pincher Creek area from January 1 to March 24, 1981. The survey was carried out to determine whether air pollution levels during the winter varied significantly from the levels obtained during the spring 1980 survey.

The survey found no variation in the mean concentration values of the pollutants monitored. However, a peak one-hour average of 0.033 ppm was recorded for hydrogen sulphide (cf. 0.017 ppm during the spring 1980 survey); and a peak one-hour average of 0.04 ppm was recorded for sulphur dioxide (cf. 0.03 ppm during the spring 1980 survey). The peak one-hour average concentrations for the other pollutants were lower during the winter 1981 survey.

Of the eight pollutants monitored during this survey--hydrogen sulphide, sulphur dioxide, total oxides of nitrogen, nitrogen dioxide, ozone, total hydrocarbons, carbon monoxide, and soiling index--only hydrogen sulphide and ozone did not consistently meet the air quality standards. Hydrogen sulphide concentrations in excess of the one-hour standard of 0.010 ppm were observed three times, with a peak reading of 0.033 ppm; ozone concentrations in excess of the 24-hour standard of 0.025 ppm were recorded an average of 96.1 percent of the total monitoring period, with a peak reading of 0.061 ppm. Such values however represent levels that are well below the levels at which health effects have been documented.

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1. INTRODUCTION

The Air Quality Control Branch of Alberta Environment carried out an ambient air monitoring survey in the Pincher Creek area from March 1 to May 31, 1980 (spring 1980). The purpose of the survey was to determine whether air pollutants resulting from gas plant operations were linked to the health concerns of the residents.

The results of the monitoring of sulphur dioxide (SO_2) and hydrogen sulphide (H_2S) in particular, as well as other common pollutants, were unable to confirm any link between the monitored air pollutant levels and the complaints of the residents.[1] However, because there was some concern by the residents that the health problems were aggravated by winter conditions, a comparative survey was initiated on January 1, 1981 and completed on March 24, 1981 (winter 1981).

As in the previous survey, the focus is again on the ambient levels of SO_2 and H_2S. However, other common pollutants such as the nitrogen oxides, ozone, total hydrocarbons, carbon monoxide, and soiling index were also monitored, mainly to determine attainment or nonattainment of the air quality standards.

For this survey, the original trailer location was maintained--5.8 kilometres east-southeast of the Shell Canada Resources plant at Waterton, and 2.5 kilometres west-southwest of the Gulf Oil Canada plant at Pincher Creek (Figure 1).

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[1]Alberta Environment, Pollution Control Division. Air Quality Monitoring Report, Pincher Creek Area. (March 1 to May 31, 1980) Edmonton, Alberta, November 1980.

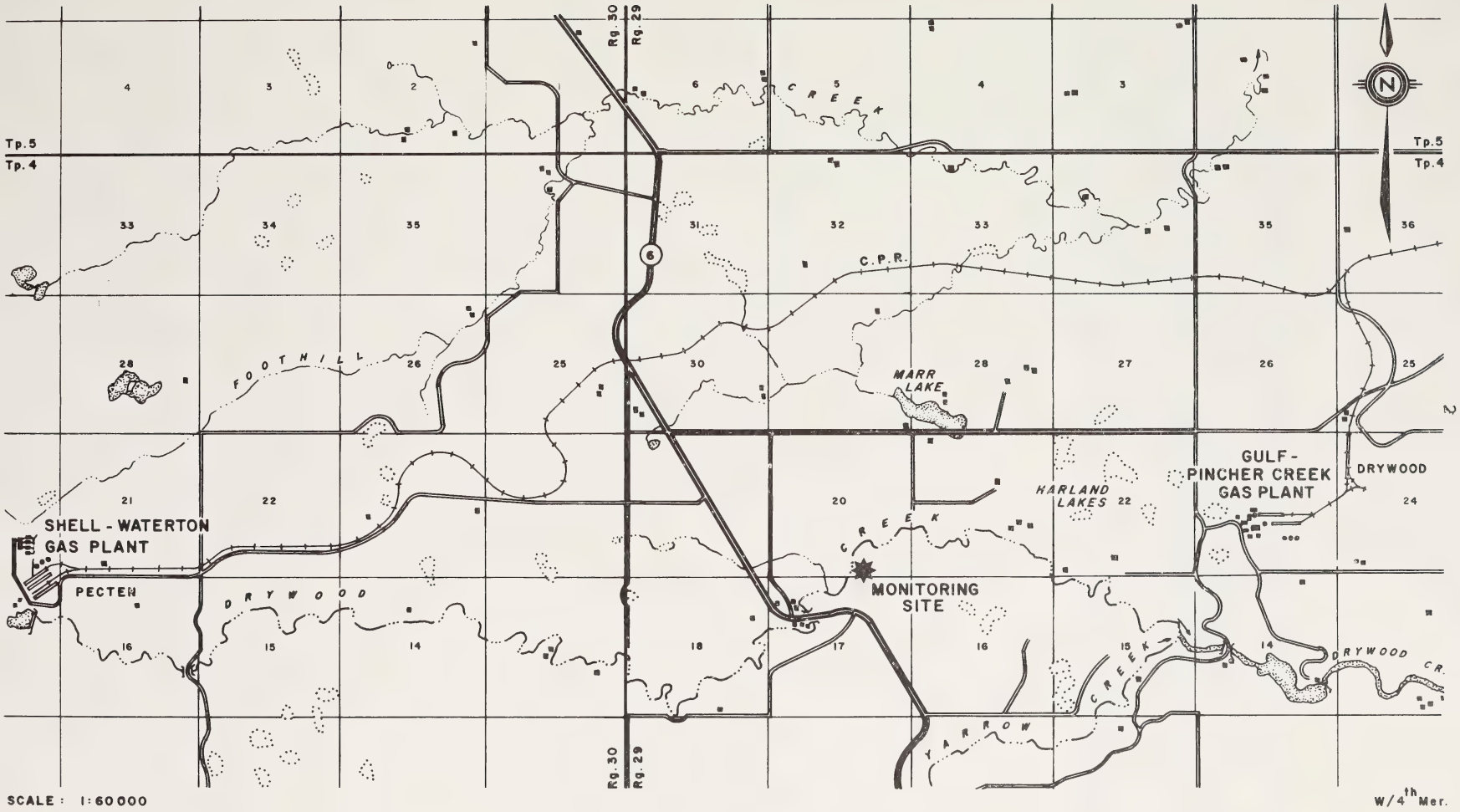

Figure 1 - MAP SHOWING LOCATIONS OF THE AIR MONITORING TRAILER AND GAS PLANTS

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In the sections that follow the results of the follow-up survey are presented. First, the data are compared with the Alberta Clean Air (Maximum Levels) Regulations to assess the air quality of the area with respect to the standards; and second, a comparison of the two data sets are made to determine whether there is seasonal variation in the ambient levels of the pollutants.

2. RESULTS

2.1 COMPARISON OF OBSERVED POLLUTANT LEVELS WITH REGULATIONS

The results presented here are in the form of arithmetic mean concentrations (typical concentration values observed for one-hour periods), maximum one-hour and 8 or 24-hour average concentrations, and the frequency of readings in excess of the Regulations. The operational time of the monitoring instrument is also given as the data are not considered to be representative when the instrument is operational for less than 75 percent of the monitoring period.

Examination of Tables 1 through 8 reveals that only the air quality standards for hydrogen sulphide and ozone were exceeded. The levels of the remaining pollutants were well below the maximum permissible levels specified in the Alberta Regulations.

No violations of the one-hour ozone standard were observed, however, ozone concentrations in excess of the 24-hour standard of 0.025 ppm were recorded an average of 96.1 percent of the total monitoring period, with a peak reading of 0.061 ppm. For hydrogen sulphide, the one-hour standard of 0.010 ppm was exceeded three times. The maximum hourly average concentration was 0.033 ppm.

2.2 WIND

The frequency distribution of wind is presented in Table 9. The table lists the frequency of occurrence of calm conditions and the frequency of occurrence of wind from eight directions for each month of the survey. Figure 2 illustrates the distribution for the total monitoring period (January 1 to March 24, 1981).

Table 9 and Figure 2 indicate that the wind conditions were predominantly calm, with westerly winds accounting for the second highest frequency.

TABLE 1

SUMMARY OF HYDROGEN SULPHIDE LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation* Exceeded	
		1-hr	24-hr		1-hr	24-hr
Jan. 1-31 '81	0.00	0.009	0.001	88.0	0.0	0.0
Feb. 1-28 '81	0.00	0.033	0.002	84.5	0.5	0.0
Mar. 1-24 '81	0.00	0.008	0.002	98.4	0.0	0.0

* Alberta Clean Air (Maximum Levels) Regulations: 1-hr--0.010 ppm; 24-hr--0.003 ppm.

TABLE 2

SUMMARY OF SULPHUR DIOXIDE LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation* Exceeded	
		1-hr	24-hr		1-hr	24-hr
Jan. 1-31 '81	0.00	0.02	0.00	88.6	0.0	0.0
Feb. 1-28 '81	0.00	0.05	0.01	92.4	0.0	0.0
Mar. 1-24 '81	0.00	0.05	0.01	95.8	0.0	0.0

* Alberta Clean Air (Maximum Levels) Regulations: 1-hr--0.17 ppm; 24-hr--0.06 ppm.

TABLE 3

SUMMARY OF TOTAL OXIDES OF NITROGEN LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation Exceeded	
		1-hr	24-hr		1-hr	24-hr
Jan. 1-31 '81	0.00	0.02	0.01	99.2	No Regulation	
Feb. 1-28 '81	0.00	0.01	0.01	99.0		
Mar. 1-24 '81	0.00	0.02	0.00	89.4		

TABLE 4

SUMMARY OF NITROGEN DIOXIDE LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation* Exceeded	
		1-hr	24-hr		1-hr	24-hr
Jan. 1-31 '81	0.00	0.02	0.01	99.2	0.0	0.0
Feb. 1-28 '81	0.00	0.01	0.01	99.0	0.0	0.0
Mar. 1-24 '81	0.00	0.02	0.00	89.4	0.0	0.0

* Alberta Clean Air (Maximum Levels) Regulations: 1-hr--0.21 ppm; 24-hr--0.11 ppm.

TABLE 5

SUMMARY OF OZONE LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation* Exceeded	
		1-hr	24-hr		1-hr	24-hr
Jan. 1-31 '81	0.034	0.060	0.047	99.2	0.0	91.1
Feb. 1-28 '81	0.042	0.060	0.049	89.6	0.0	99.7
Mar. 1-24 '81	0.051	0.070	0.061	89.8	0.0	97.5

* Alberta Clean Air (Maximum Levels) Regulations: 1-hr--0.080 ppm; 24-hr--0.025 ppm.

TABLE 6

SUMMARY OF TOTAL HYDROCARBON LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation Exceeded	
		1-hr	24-hr		1-hr	24-hr
Jan. 1-31 '81	1.8	3.1	2.3	76.9	No Regulation	
Feb. 1-28 '81	1.8	2.6	2.1	58.2		
Mar. 1-24 '81	1.8	2.2	2.2	22.7		

TABLE 7

SUMMARY OF CARBON MONOXIDE LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (ppm)	Maximum Readings (ppm)		Percentage of Time Instrument Operational	Percentage of Time Regulation* Exceeded	
		1-hr	8-hr		1-hr	8-hr
Jan. 1-31 '81	0.34	1.0	1.0	100	0.0	0.0
Feb. 1-28 '81	0.43	1.5	1.0	90.2	0.0	0.0
Mar. 1-24 '81	0.19	1.0	0.6	73.1	0.0	0.0

* Alberta Clean Air (Maximum Levels) Regulations: 1-hr--13.0 ppm; 8-hr--5.0 ppm.

TABLE 8

SUMMARY OF SOILING INDEX LEVELS

FOR THE PINCHER CREEK AREA

Monitoring Period	Arithmetic Mean (COH)	Maximum Readings (COH)		Percentage of Time Instrument Operational	Percentage of Readings greater than 1.0 COH*
		1-hr	24-hr		
Jan. 1-31 '81	0.01	0.20	0.05	100	0.0
Feb. 1-28 '81	0.02	0.50	0.12	100	0.0
Mar. 1-24 '81	0.01	0.30	0.08	99.5	0.0

* Alberta Environment guidelines require that no more than 10% of the readings should be greater than 1.0 COH (Coefficient of Haze).

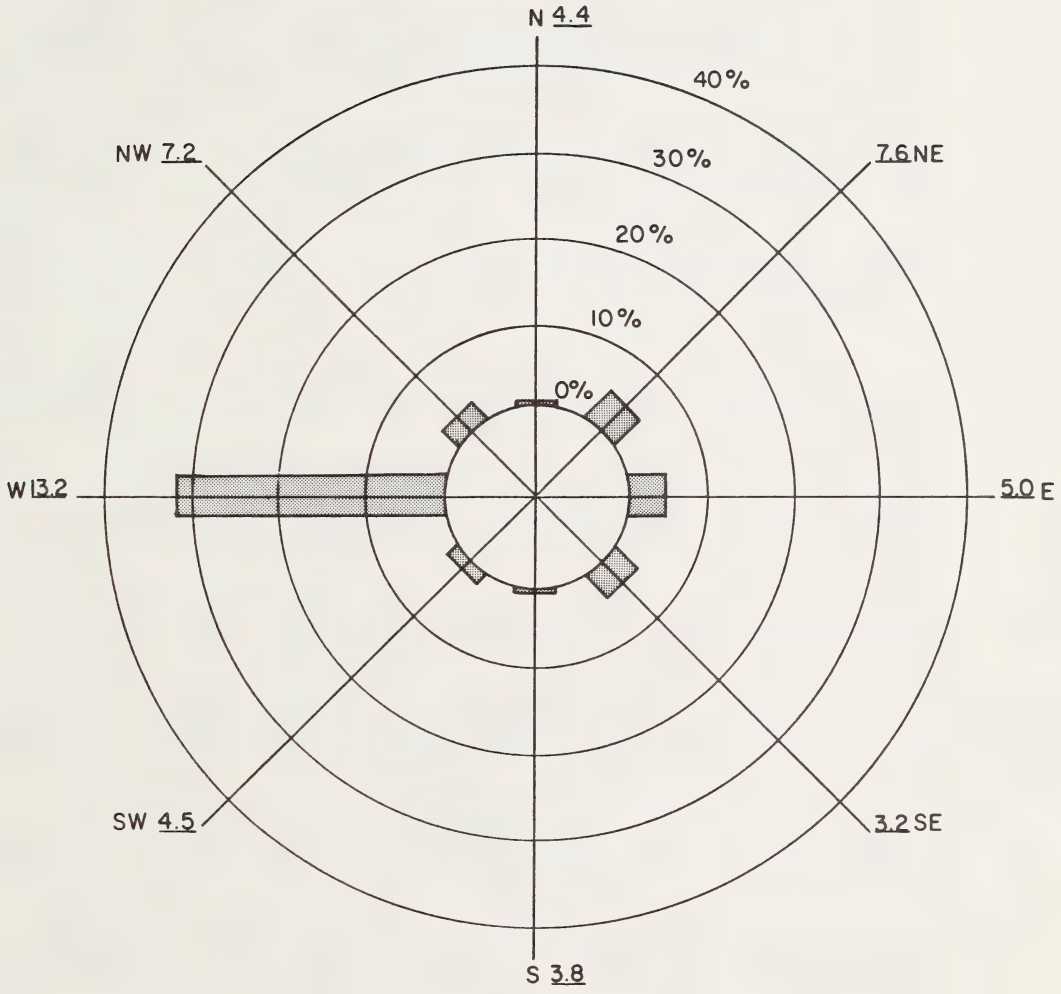
TABLE 9

FREQUENCY DISTRIBUTION OF WIND

FOR THE PINCHER CREEK AREA

Monitoring Period	Wind Direction (percent frequency)									Percentage of Time Instrument Operational
	Calm	N	NE	E	SE	S	SW	W	NW	
Jan. 1-31 '81	53.6	0.8	1.5	2.8	0.4	0.1	0.7	15.6	1.1	76.6
Feb. 1-28 '81	29.3	0.6	7.3	6.1	2.4	0.6	2.7	49.4	1.6	100
Mar. 1-24 '81	41.2	0.4	5.2	4.7	8.0	0.7	1.4	32.1	5.9	99.5
Average for Period	41.4	0.6	4.7	4.5	3.6	0.5	1.6	32.4	2.9	92.0

FIGURE 2 – FREQUENCY DISTRIBUTION OF WIND IN THE PINCHER CREEK AREA (JANUARY - MARCH, 1981)



Wind Speeds are Shown at the Outer Circle
Average Wind Speed - 6.1 km/h
Calm Winds - 41.4 %

3. COMPARISON OF DATA SETS

Figures 3 and 4 illustrate the variation in pollutant levels between spring 1980 and winter 1981 in the Pincher Creek area. Plotted are the arithmetic mean concentrations, the maximum 24-hour average concentrations, and the maximum one-hour average concentrations. The figures show an increase in the maximum one-hour average H_2S and SO_2 concentrations in the winter of 1981. For the remaining pollutants, a general trend of decreasing ambient levels is evident, however, ozone concentrations in excess of the 24-hour standard continued to be observed. It is worth noting though that the observed peak ozone values represent concentrations that are well below the levels at which health effects have been documented.[2]

Although there is a significant increase in the observed maximum one-hour average H_2S concentrations (0.033 ppm in winter 1981 compared to 0.017 ppm in spring 1980), typical hourly values were 0.00 ppm (Table 10). Of a possible 1,790 hourly readings, three exceeded the one-hour standard of 0.010 ppm, and of these, one reached a value of 0.033 ppm.

The observed increase in the peak hourly H_2S and SO_2 average concentrations can be due primarily to changes in meteorological factors. Because wind speed and direction influence the horizontal dispersion of emissions and consequently ambient pollutant concentrations, any changes in the two variables will influence ground level concentrations. For example, an increase in the frequency of winds from the direction of a pollutant source can result in increased concentrations downwind from the source. During this survey there was a

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[2]Ibid., p. 10.

twofold increase in the frequency of west winds, i.e. winds blowing from the direction of the Shell-Waterton plant towards the monitoring trailer.

The more stable atmospheric conditions and low wind speeds which occur during the winter can also result in a decreased dispersion of pollutants, and contribute to the occurrence of higher concentrations.

FIGURE 3 - VARIATION OF AMBIENT POLLUTANT (H_2S, SO_2, NO_x, NO_2) CONCENTRATIONS FOR THE PINCHER CREEK AREA

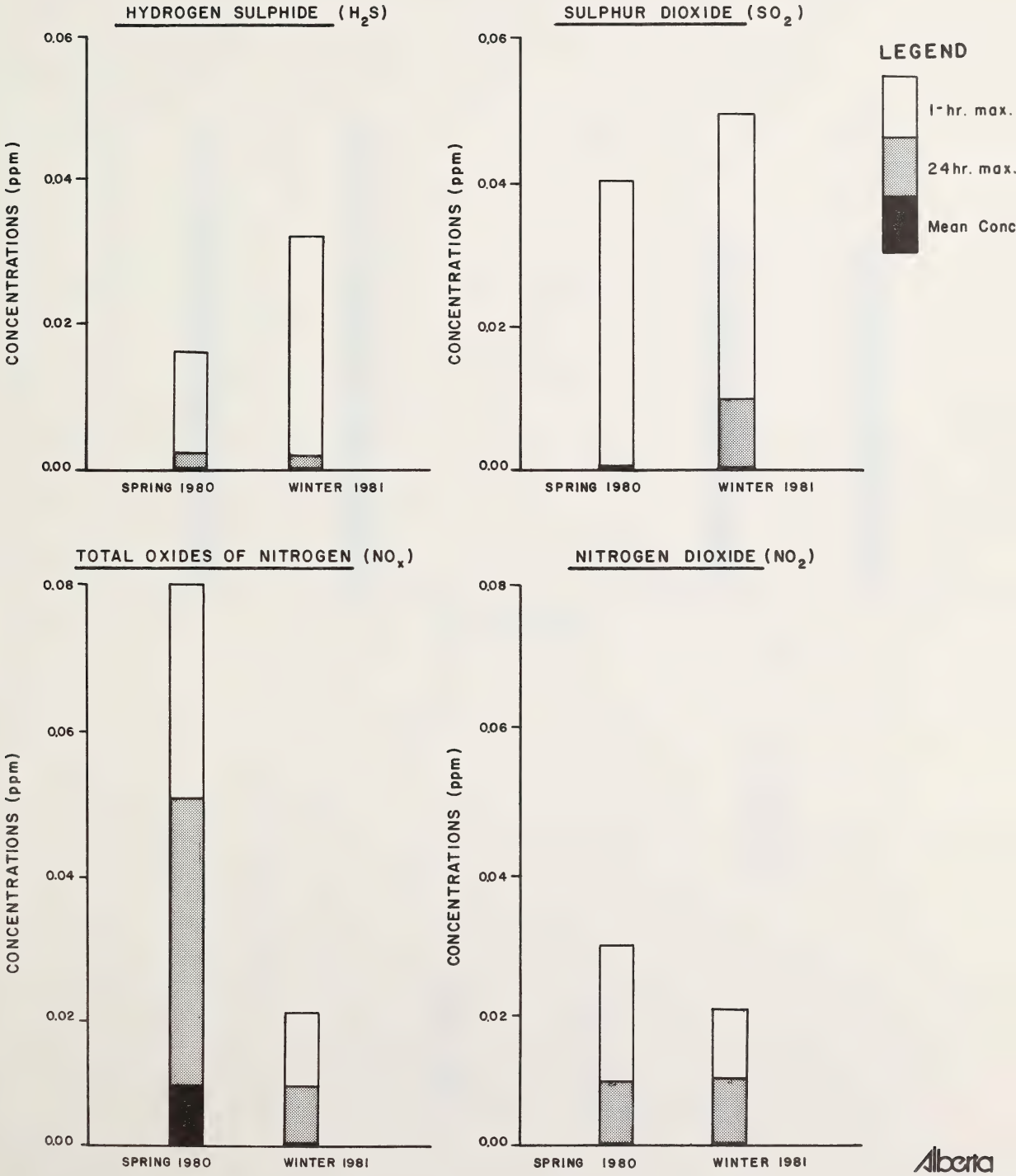

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FIGURE 4 – VARIATION OF AMBIENT POLLUTANT (O_3, THC, SOILING INDEX) CONCENTRATIONS FOR THE PINCHER CREEK AREA

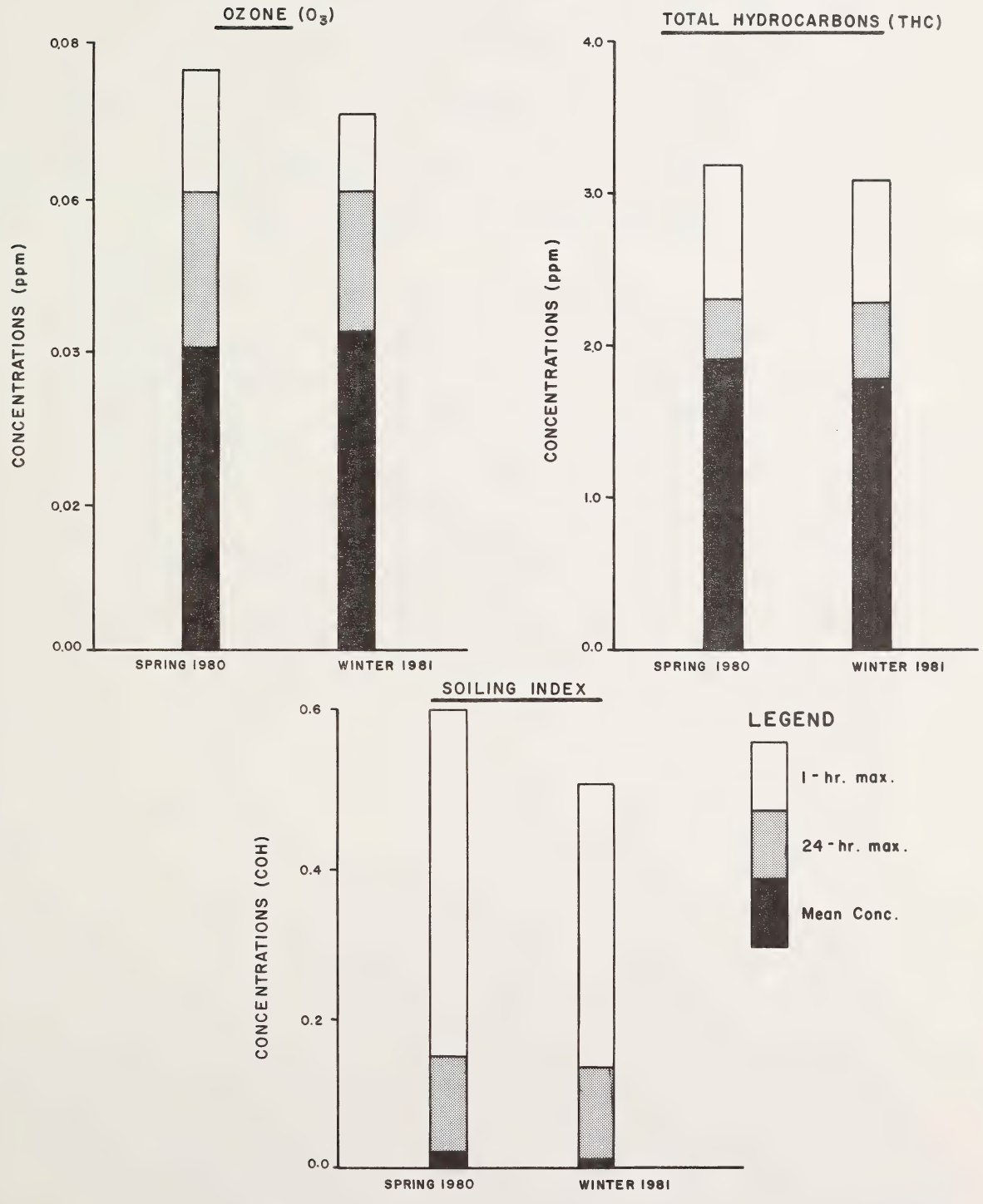

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TABLE 10

FREQUENCY DISTRIBUTION OF HYDROGEN SULPHIDE

CONCENTRATIONS FOR THE PINCHER CREEK AREA

Concentration Range (ppm)	(%) Frequency of Occurrence	
	Spring 1980	Winter 1981
0.0000	92.2	96.1
0.0010 - 0.0060	6.9	2.9
0.0070 - 0.0120	0.8	0.8
0.0130 - 0.0990	0.2	0.2

4. CONCLUSIONS

An ambient air monitoring survey carried out in the Pincher Creek area from January 1 to March 24, 1981 (winter 1981) found no variation in the mean H_2S and SO_2 concentrations observed during the spring 1980 and winter 1981. The peak hourly average for H_2S, though, increased by 0.016 ppm, and the peak hourly average for SO_2 increased by 0.01 ppm. The levels of the other pollutants--measured mainly to determine the area's status with regard to the Alberta air quality standards--decreased during the winter months. However, the 24-hour air quality standard for ozone continued to be exceeded.

The health effect criteria for both H_2S and ozone indicate that there are no adverse effects on human health at the levels monitored in the Pincher Creek area.

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